WHAT IS CLAIMED IS:

1. A process comprising the steps of:

a) providing a plurality of carbon nanotubes;

b) cutting the carbon nanotubes to provide cut carbon nanotubes comprising lengths on the order of tens of nanometers;

c) sorting the cut carbon nanotubes by type to provide sorted cut carbon nanotubes;

d) docking at least some of the sorted cut carbon nanotubes to metal catalyst precursors to form carbon nanotube seeds; and

e) growing the carbon nanotube seeds to form a carbon nanotube product of increased length.

2. The process of claim 1, wherein the carbon nanotubes are selected from the group consisting of single-wall carbon nanotubes, multi-wall carbon nanotubes, double-wall carbon nanotubes, and combinations thereof.

3. The process of claim 1, wherein the carbon nanotubes are single-wall carbon nanotubes.

4. The process of claim 3, further comprising a step of cycling some of the single-wall carbon nanotubes product back into the process.

5. The process of claim 3, wherein the single-wall carbon nanotubes are cut by a method selected from the group consisting of partial fluorination, selective ozonation, superacid treatment, and combinations thereof.

6. The process of claim 3, further comprising a step of chemically derivatizing the cut single-wall carbon nanotubes.

7. The process of claim 6, wherein the cut single-wall carbon nanotubes undergo selective chemical derivatization based on type.

8. The process of claim 7, wherein the selective chemical derivatization is used to sort the single-wall carbon nanotubes by type.

9. The process of claim 3, wherein the cut single-wall carbon nanotubes are sorted by a method selected from the group consisting of selective chemical functionalization, selective protonation, superacid extraction, and combinations thereof.

10. The process of claim 3, wherein the metal catalyst precursor is a molecular cluster comprising a suitable metal catalyst.

11. The process of claim 3, wherein the metal catalyst precursor is FeMoC.

12. The process of claim 3, wherein the metal catalyst precursor is FeMoC(EtOH).

13. The process of claim 3, wherein docking the sorted cut single-wall carbon nanotube to metal catalyst precursors comprises an initial attachment.

14. The process of claim 11, wherein docking the sorted cut single-wall carbon nanotubes to the metal catalyst precursor comprises a displacement of coordinated water molecules with carboxylic groups on the single-wall carbon nanotube ends during the initial attachment.

15. The process of claim 12, wherein docking the sorted cut single-wall carbon nanotubes to the metal catalyst precursor comprises a displacement of coordinated ethanol molecules with carboxylic groups on the single-wall carbon nanotube ends during the initial attachment.

16. The process of claim 13 or 14 further comprising a step of purifying to remove unattached metal catalyst precursors.

17. The process of claims 3-15, or 16, wherein docking the sorted cut single-wall carbon nanotubes to the metal catalyst precursor further comprises reducing the metal catalyst precursor to its metallic state in a reducing environment.

18. The process of claim 17, wherein the reducing environment comprises hydrogen.

19. The process of claims 1-17, or 18, wherein the growth environment comprises a support.

20. The process of claims 3-18, or 19, wherein placing the single-wall carbon nanotubes seeds in a growth environment comprises an injection process with subsequent nanotube seed aerosol formation.

21. The process of claims 1-19, or 20, wherein the growth environment comprises CO and H_2.

22. The process of claims 3-20, or 21, wherein said process is scalable so as to produce multi-kilogram quantities of precise populations of single-wall carbon nanotubes.

23. A process comprising the steps of:

a) providing a plurality of carbon nanotubes, wherein substantially all of the carbon nanotubes are of a sorted pre-selected chirality and diameter;

b) forming carbon nanotube seeds from the plurality of carbon nanotubes;

c) growing the carbon nanotube seeds in a growth environment to provide a carbon nanotube product comprising carbon nanotubes of increased length and of the pre-selected chirality and diameter.

24. The process of claim 23, wherein the carbon nanotubes are selected from the group consisting of single-wall carbon nanotubes, multi-wall carbon nanotubes, double-wall carbon nanotubes, and combinations thereof.

25. The process of claim 23, wherein the carbon nanotubes are single-wall carbon nanotubes.

26. The process of claim 25, wherein the single-wall carbon nanotube product is utilized for hydrogen storage.

27. The process of claim 26, wherein the plurality of single-wall carbon nanotubes is pre-selected for optimum hydrogen storage.

28. The process of claim 25, wherein forming single-wall carbon nanotube seeds comprises the steps of:

a) attaching a metal catalyst precursor species to the ends of the single-wall carbon nanotubes to form inactive single-wall carbon nanotube seeds; and

b) reductively docking the metal catalyst precursor material to the ends of the single-wall carbon nanotubes in a reducing environment to form active single-wall carbon nanotube seeds.

29. The process of claims 23-27, or 28 further comprising a step of cutting the single-wall carbon nanotubes of pre-selected chirality and diameter with a cutting process so as to provide cut single-wall carbon nanotubes with lengths on the order of tens of nanometers.

30. The process of claim 29, wherein the single-wall carbon nanotubes are cut by a method selected from the group consisting of partial fluorination, selective ozonation, superacid treatment, and combinations thereof

31. The process of claim 28, wherein the metal catalyst precursor is a molecular cluster comprising a suitable metal catalyst.

32. The process of claim 28, wherein the metal catalyst precursor is FeMoC.

33. The process of claim 28, wherein the metal catalyst precursor is FeMoC(EtOH).

34. The process of claim 28, wherein the metal catalyst precursor is an organometallic species.

35. The process of claims 28-33, or 34, wherein the reducing environment comprises hydrogen.

36. The process of claims 23-34, or 35, wherein the growth environment comprises a support.

37. The process of claims 25-35, or 36, wherein placing the single-wall carbon nanotubes seeds in a growth environment comprises an injection process with subsequent nanotube seed aerosol formation.

38. The process of claims 23-36, or 37, wherein the growth environment comprises CO and H_2.

39. A composition comprising:

a) a functionalized carbon nanotube; and

b) a metal-containing compound attached to at least one end of the carbon nanotube, wherein the metal-containing compound comprises functionality that is complementary to functionality of the carbon nanotube end.

40. The composition of claim 39, wherein the carbon nanotube is a single-wall carbon nanotube.

41. The composition of claim 39, wherein the metal-containing compound is a catalyst precursor.

42. The composition of claims 39-40, or 41, wherein the metal containing compound is a metal cluster.

43. The composition of claims 39-41, or 42, wherein the metal-containing compound contains elements selected from the group consisting of iron, chromium, molybdenum, nickel, cobalt, and combinations thereof.

44. The composition of claims 39-42, or 43, wherein the metal-containing compound is a transition metal oxide.

45. The composition of claim 42, wherein the metal cluster is FeMoC.

46. The composition of claim 40, wherein the single walled carbon nanotube is side-wall functionalized with sidewall functional group moieties to inhibit further reaction at the side walls.

47. The composition of claim 40, wherein the single walled carbon nanotube is side-wall functionalized with sidewall functional group moieties to enhance solubility and separation.

48. The composition of claim 40, wherein the single walled carbon nanotube is side-wall functionalized with sidewall functional group moieties to prevent roping.

49. The composition of claims 46-47, or 48, wherein the side-wall functional group moieties are selected from the group consisting of halogen, nitro, cyano, alkyl, aryl, arylalkyl, carboxylic ester, carboxylic acid, thiocarbonate, sulfonate, amide, alkoxy, polyether, hydroxyl, and combinations thereof.

50. The composition of claims 39-48, or 49, wherein the carbon nanotube has been end-functionalized to allow chemical bonding to the metal-containing compound.

51. The composition of claims 39-49, or 50, wherein the metal-containing compound has been functionalized to allow chemical bonding to the carbon nanotube.

52. The composition of claim 50, wherein the carbon nanotube has been functionalized with carboxylate groups.

53. The composition of claim 52, wherein the metal-containing compound contains complementary functional groups.

54. The composition of claim 50, wherein the metal-containing compound comprises leaving groups that allow for the reaction between the metal-containing compound and the carbon nanotube to occur.

55. The composition of claim 54, wherein the leaving groups are chosen from the group consisting of methanol, ethanol, alcohol, amine, thiol, ketone, dimethylsulfoxide (DMSO), tetrahydrofuran (THF), and combinations thereof.

56. A method of making the composition of claim 39 comprising the steps of:

a) functionalizing at least one end of a carbon nanotube;

b) functionalizing a metal-containing compound with functionality that is complementary to that of the carbon nanotube end; and

c) attaching the carbon nanotube to a metal-containing compound through such complementary functionality.

57. A method comprising the steps of:

a) functionalizing carbon nanotubes to protect their sidewalls from further reaction and to produce individual carbon nanotubes;

b) functionalizing the carbon nanotubes at their ends;

c) functionalizing a quantity of metal-containing compound with functionality that is complementary to that of the carbon nanotube ends; and

d) reacting the carbon nanotubes and metal-containing compound to generate carbon nanotube-cluster complexes.

58. The method of claim 57, wherein the step of reacting involves a coupling selected from the group consisting of acid-base complexation, ligand exchange, an oxidative addition reaction, a condensation reaction, and combinations thereof.

59. A composition of matter comprising:

a) a functionalized carbon nanotube;

b) a metal-containing compound attached to at least one end of the carbon nanotube, wherein the metal-containing compound comprises functionality that is complementary to functionality of the carbon nanotube end; and

c) a support material on which the carbon nanotube and the metal-containing compound reside.

60. The composition of claim 59, wherein the carbon nanotube is attached to the support.

61. The composition of claim 59 or 60, wherein the transition metal compound is attached to the support.

62. The composition of claims 59-60, or 61, wherein the support is used as a catalyst support for the growth of nanotubes.

63. The composition of claims 59-61, or 62, wherein the support has a functionalized surface.

64. A process comprising:

a) reacting a sidewall-functionalized carbon nanotube with a metal-containing compound; and

b) heating the product from the reaction between the carbon nanotube and the metal-containing compound under conditions to convert the functionalized carbon nanotube to an unfunctionalized carbon nanotube.

65. A process comprising:

a) reacting a sidewall-functionalized carbon nanotube with a metal-containing compound;

b) heating the product from the reaction between the carbon nanotube and the metal-containing compound under conditions to convert the functionalized carbon nanotube to an unfunctionalized carbon nanotube; and

c) converting the metal-containing compound to a metal particle.

66. The process of claim 65 further comprising a step of exposing to a reagent that allows amplification of the carbon nanotube.

67. The process of claim 65 or 66, wherein the amplification of the carbon nanotube is homogenous with respect to type.

68. A method comprising the steps of:

a) preparing a mixture of $H_3[P(Mo_2O_{10})_4]$, $FeCl_2$, Na_2MoO_4, and CH_3CO_2H; and

b) reacting the mixture components to form FeMoC.

69. The method of claim 68, wherein the mixture is prepared as an aqueous soulution.

70. The method of claim 69 further comprising a step of reducing the mixture to dryness after the mixture components have reacted to form the FeMoC.

71. The method of claim 70 further comprising a step of purifying, wherein the FeMoC is purified via Soxhlet extraction.

72. The method of claim 71, wherein the Soxhlet extraction is done with ethanol.

73. The method of claim 72, wherein the purified FeMoC is FeMoC(EtOH).

74. A method comprising the steps of:

a) providing a cut carbon nanotube with end functionality;

b) attaching a FeMoC(EtOH) metal cluster, made by the method of claim 73, to an end of the carbon nanotube;

c) reductively docking the metal cluster to the carbon nanotube to form an active carbon nanotube seed;

d) exposing the active carbon nanotube seed to growth conditions to form a carbon nanotube product of increased length.

75. The method of claim 74, wherein the carbon nanotube is a single-wall carbon nanotube.

76. The process of claim 23, wherein the step of forming carbon nanotube seeds comprises disposing on the sidewalls of the carbon nanotubes a quantity of bonded metal catalyst precursor material sufficient to provide active catalyst metal atom clusters for growing carbon nanotubes under conditions that promote the generation of metal atoms and the migration of said metal atoms to the free ends of the said carbon nanotubes.

77. The process of claim 76, wherein the carbon nanotubes are selected from the group consisting of single-wall carbon nanotubes, multi-wall carbon nanotubes, double-wall carbon nanotubes, and combinations thereof.

78. The process of claim 76, wherein the carbon nanotubes are single-wall carbon nanotubes.